Dedication

To
My mother Guruvammal and my family (Vasuki wife, and daughters Virupa, and Uma)
- *Muthu Ramachandran*

To
My sister Khalida and brother Masood
- *Zaigham Mahmood*

Preface

Overview

Requirements Engineering (RE) is the process of discovering, documenting and managing the requirements for a computer-based system. The goal is to produce a set of specifications, as the first stage in the system development process, to form the basis for further design and development of the required system. Since the production of a complete, correct and unambiguous set of requirements has numerous inherent issues, RE has become an important research topic in the field of Software Engineering. Additionally, with the emergence of the Cloud Computing paradigm, developments in Social Media and Service Computing, inherent challenges of the RE process have grown in numbers and complexity. This is because the new software systems are expected to be scalable, operable on all varieties of diverse platforms, sustainable, fail safe, and, in general, suitable for Distributed Computing environments. Now, software is being deployed as Web Services and as Software-as-a-Service (SaaS) to be consumed by users on a wide variety of diverse smart devices, via the Internet protocols.

The current approaches to developing SaaS, embedded systems and enterprise applications, using methodologies such as service-orientation and component-based design, have their main focus on meeting the increasing levels of demands for distributed software as a service that is more accessible, configurable (over a distributed large scale global network) and shareable for multi-tenancy. In the recent past, we have known software as functions, objects, classes, components, and even frameworks. However, the concept of a *software service* is new and different from the traditional software engineering perspective. In this context, the notion of a software product has changed considerably.

Unfortunately, there is a distinct lack of systematic approaches and methodologies to identify, define, visualize, specify and validate requirements for such services, although, there are some developments underway by way of new products and methodologies to cater for the needs of the industry. Also, the current software systems are beyond the traditional stakeholder concept. In respect to the newer approaches, the user base is now much wider and data and applications are shared through Social Media and other networked mobile technologies.

With this background, there is an urgent need for properly integrated solutions, taking into account the requirements of scalability, flexibility, sustainability and operability for distributed computing environments. In this respect, the current text is probably the first book on the topic of RE for Service and Cloud Computing.

This book, *Requirements Engineering for Service and Cloud Computing,* aims to capture the state of the art on the current advances in requirements engineering. Majority of the contributions in this book, focus on: requirements elicitation; requirements specifications; requirements classification and requirements validation and evaluation. Thirty-six researchers and practitioners of international repute have presented latest research developments, methodologies, current trends, state of the art reports, case studies and suggestions for further understanding, development and enhancement of subject area of requirements engineering for software systems for distributed environments.

Objectives

The aim of this volume is to present and discuss the state-of-the-art in terms of methodologies, trends and future directions for requirements engineering for the service and cloud computing paradigm. The objectives include:

- Capturing the state of the art research and practice relating to requirements engineering for the service and cloud computing
- Discussing developments, tools, technologies and trends in the subject area of software requirements engineering
- Analyzing the relevant theoretical frameworks, practical approaches and methodologies for service requirements
- In general, advancing the understanding of the emerging new methodologies relevant to requirements engineering for the service and cloud computing.

Organization

There are 13 chapters in *Requirements Engineering for Service and Cloud Computing*. These are organized in three parts, as follows:

- **Part I: Requirements Elicitation for Service and Cloud Computing**. Requirements elicitation is the first key component of requirements engineering that involves various stakeholders to identify and clarify requirements for services' development. This section has a focus on various approaches, research and practices towards requirements elicitation. There are five chapters in this part. The first chapter discusses experiences gained from participation in a number of large, commercial information system development projects in both public and private sectors in which the traditional way of handling the requirements has proven to be insufficient. Chapter 2 presents Cloud dimensions that are graphically presented via conceptual models, as each dimension has specific entities, properties, and relationships. Chapter 3 presents approaches to requirements engineering for cloud-based environments; whereas Chapter 4 presents an Overall Aggregated Effective Quality of Service (OAEQoS) model for capturing non-function requirements. Chapter 5 probes further into requirements engineering for software-defined cloud environments.

- **Part II: *Requirements Specification for Service and Cloud Computing***. This part of the book comprises three chapters that focus on requirements specification. The first chapter presents an abstraction layer for SaaS architecture with a focus on Multi-agent based Inter-cloud environment, called Enterprise Cloud Bus System (ECBS), to conceptualize the different behavioral facets of software systems in service and cloud computing paradigm. The next chapter discusses an approach on how BPMN nodes are mapped to services and presents an algorithm for dynamic discovery of appropriate services. The final contribution in this section suggests a framework for requirements classification and change management focusing on distributed Platform-as-a-Service (PaaS) and Software-as-a-Service (SaaS) systems as well as complex software ecosystems that are built using PaaS and SaaS, such as Tools-as-a-Service (TaaS).

- **Part III: *Requirements Validation, Evaluation, and QoS for Service and Cloud Computing***. There are four chapters in this section that focus on requirements validation, evaluation and Quality of Service (QoS). The first three chapters present appraisal and analysis of inherent security requirements, and discuss ways to make transition from Information Systems to Web Services. The fourth contribution in this part addresses an approach to simulating composite Web Services for predicting the QoS parameters. The final contribution presents a set of distributed agile requirements engineering patterns after several validation process.

Target Audiences

The current volume is a reference text aimed at supporting a number of potential audiences, including the following:

- *Software Engineers* and *Project Managers* who wish to adopt the newer approaches to ensure the accurate and complete system specifications.
- *Students and lecturers* who have an interest in further enhancing the knowledge of technologies, mechanisms and frameworks relevant to Requirements Engineering for distributed environments.
- *Researchers* in this field who require up to date knowledge of the current practices, mechanisms and frameworks relevant to Systems' Requirements Engineering.

Zaigham Mahmood, Univ of Derby UK & North West University S Africa
Muthu Ramachandran, Leeds Beckett University, UK

Acknowledgements

The editors acknowledge the help and support of the following colleagues during the review, development and editing phases of this text:

- Dr S Parthasarathy, Thiagarajar College of Engineering, Tamil Nadu, India
- Dr Pethuru Raj, IBM Cloud Center of Excellence, Bangalore, India
- Prof Andrea Zisman, Open University
- Prof Bashar Nuseibeh, Open University
- Prof T R G Nair, Raja Rajeswari College of Engineering, India

We would also like to thank the contributors to this book: 34 authors and co-authors, from academia as well as industry from around the world, who collectively submitted twelve chapters. Without their efforts in developing quality contributions, conforming to the guidelines and meeting often the strict deadlines, this text would not have been possible.

Muthu Ramachandran
School of Computing, Creative Technologies, and Engineering
Leeds Beckett University, UK

&

Zaigham Mahmood
University of Derby, UK
North West University, Potchefstroom, S Africa

31 October 2016

Other Springer Books by the Editors

Strategic Systems Engineering for Cloud and Big Data

By Muthu Ramachandran

This reference text provides state of the approaches on strategic approaches to cloud computing and big data.

Enterprise Security

By Muthu Ramachandran

This book provides state of the art approaches on enterprise security, cloud security, and big data security issues.

Cloud Computing: Challenges, Limitations and R&D Solutions

By Zaigham Mahmood

This reference text reviews the challenging issues that present barriers to greater implementation of the Cloud Computing paradigm, together with the latest research into developing potential solutions. This book presents case studies, and analysis of the implications of the cloud paradigm, from a diverse selection of researchers and practitioners of international repute. ISBN: 978-3-319-10529-1.

Continued Rise of the Cloud: Advances and Trends in Cloud Computing

By Zaigham Mahmood

This reference volume presents latest research and trends in cloud related technologies, infrastructure, and architecture. Contributed by expert researchers and practitioners in the field, this book presents discussions on current advances and practical approaches including guidance and case studies on the provision of cloud-based services and frameworks. ISBN: 978-1-4471-6451-7.

Cloud Computing: Methods and Practical Approaches

By Zaigham Mahmood

The benefits associated with cloud computing are enormous; yet the dynamic, virtualized and multi-tenant nature of the cloud environment presents many challenges. To help tackle these, this volume provides illuminating viewpoints and case studies to present current research and best practices on approaches and technologies for the emerging cloud paradigm. ISBN: 978-1-4471-5106-7.

Software Engineering Frameworks for the Cloud Computing Paradigm

By Zaigham Mahmood

This is an authoritative reference that presents the latest research on software development approaches suitable for distributed computing environments. Contributed by researchers and practitioners of international repute, the book offers practical guidance on enterprise-wide software deployment in the cloud environment. Case studies are also presented. ISBN: 978-1-4471-5030-5.

Cloud Computing for Enterprise Architectures

By Zaigham Mahmood

This reference text, aimed at system architects and business managers, examines the cloud paradigm from the perspective of enterprise architectures. It introduces fundamental concepts, discusses principles, and explores frameworks for the adoption of cloud computing. The book explores the inherent challenges and presents future directions for further research. ISBN: 978-1-4471-2235-7.

Data Science and Big Data Computing: Frameworks and Methodologies

By Zaigham Mahmood

This reference text has a focus on data science, and provides practical guidance on methodologies and frameworks for big data analytics. Expert perspectives are provided by an authoritative collection of 36 researchers and practitioners, discussing latest developments, emerging trends; and innovative approaches suggesting best practices for efficient data analytics. ISBN: 978-3-319-31859-2.

Connectivity Frameworks for Smart Devices: The Internet of Things from a Distributed Computing Perspective

By Zaigham Mahmood

This is an authoritative reference that focuses on the latest developments on the Internet of Things. It presents state of the art on the current advances in the connectivity of diverse devices; and focuses on the communication, security, privacy, access control and authentication aspects of the device connectivity in distributed environments. ISBN: 978-3-319-33122-5

Contents

About the Editors

Dr Muthu Ramachandran is a Principal Lecturer in the Computing, Creative Technologies, and Engineering School as part of the Faculty of Arts, Environment and Technology at Leeds Beckett University in the UK. Previously, he spent nearly eight years in industrial research (Philips Research Labs and Volantis Systems Ltd, Surrey, UK) where he worked on software architecture, reuse, and testing. His first career started as a research scientist where he worked on real-time systems development projects. Muthu is an author of books including: Software Components: Guidelines and Applications (Nova Publishers, NY, USA, 2008) and Software Security Engineering: Design and Applications (Nova Publishers, NY, USA, 2011). He has also widely authored and published 9 books, over 100s of journal articles, over 50 book chapters and over 200 conferences papers on various advanced topics in software engineering, software security, cloud computing and education. Muthu has been leading conferences as chairs and as keynote speakers on global safety, security and sustainability, emerging services, IoT, Big Data, and Software Engineering. Muthu is a member of various professional organizations and computer societies: IEEE, ACM, Fellow of BCS, and a Senior Fellow of HEA. He has also been an invited keynote speaker on several international conferences. Muthu's research projects have included all aspects of software engineering, SPI for SMEs (known as Prism model), emergency and disaster management systems, software components and architectures, good practice guidelines on software developments, software security engineering, and service and cloud computing. Projects details can be accessed at www.se.moonfruit.com and at soft-research.com

Muthu can be reached at m.ramachandran@leedsbeckett.ac.uk and re.for.cloud@gmail.com

****

Professor Dr Zaigham Mahmood is a published author/editor of seventeen books, five of which are dedicated to Electronic Government and the other eleven focus on the subjects of Cloud Computing, Data Science, Internet of Things, and Software Project Management, including: *Cloud Computing: Concepts, Technology & Architecture* which is also published in Korean and Chinese languages*; Cloud Computing: Methods and Practical Approaches; Software Engineering Frameworks for the Cloud Computing Paradigm; Cloud Computing for Enterprise Architectures; Cloud Computing Technologies for Connected Government; Continued Rise of the Cloud: Advances and Trends in Cloud Computing*; *Cloud Computing: Challenges, Limitations and R&D Solutions; Data Science and Big Data Computing: Frameworks and Methodologies*; *Connectivity Frameworks for Smart Devices: The Internet of Things from a Distributed Computing Perspective*; and *Software Project Management for Distributed Computing: Life-Cycle Methods for Developing Scalable and Reliable Tools.* Additionally, he is developing two new books to appear later in 2017. He has also published more than 100 articles and book chapters and organized numerous conference tracks and workshops.

Professor Mahmood is the Editor-in-Chief of *Journal of E-Government Studies and Best Practices* as well as the Series Editor-in-Chief of the IGI book series on *E-Government and Digital Divide*. He is a Senior Technology Consultant at Debesis Education UK and Associate Lecturer (Research) at the University of Derby UK. He further holds positions as Foreign Professor at NUST and IIU in Islamabad Pakistan and Professor Extraordinaire at the North West University Potchefstroom South Africa. Professor Mahmood is also a certified cloud computing instructor and a regular speaker at international conferences devoted to Cloud Computing and E-Government. His specialized areas of research include distributed computing, project management, and e-government.

****